

InnoAquaTech

Cross-border development and transfer
of innovative and sustainable aquaculture
technologies in the South Baltic area



Project Results and Findings

July 2019

The InnoAquaTech partners would like to thank the contributors to this brochure. Special thanks go to the Advisory Board members Torger Børresen, Jesper Heldbo, Marcin Juchniewicz and Andreas Müller-Belecke for sharing their excellent expertise.

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Dear Readers,

it is by now more than three years ago, that BioCon Valley® together with six other members of the SUBMARINER Network for Blue Growth EEIG from Denmark, Germany, Lithuania and Poland joined forces to establish the InnoAquaTech project in the framework of the INTERREG South Baltic programme. Together, we wanted to showcase the application and commercial potential of innovative aquaculture technologies in South Baltic countries.

InnoAquaTech was based on the findings of the SUBMARINER Compendium (2012), its Roadmap (2013) and the EU Commission's Blue Growth Agenda (2014), which had highlighted the growth opportunities for aquaculture, also in those Baltic Sea regions which do not have a tradition for marine aquaculture due to lack of suitable nearshore sites. This potential arises mainly from intelligent use of innovative, environmentally friendly technologies as well as changing customer demands. What was lacking at that time was a systematic cross-border cooperation and best practice exchange.

InnoAquaTech has changed this. Through our project numerous SMEs have gained access to state-of-art technology, know-how, expertise and financing models to boost the sector in the South Baltic. Through demonstration sites, we explored the broad spectrum of technologies suitable to be applied in this region, e.g. fish and shrimp farming in closed recirculation aquaculture systems (RAS), integrated microalgae cultivation in photo-bioreactors (PBR) and plant aquaponics.

With this brochure we want to present you a snapshot of what has been achieved: You will learn about the pilot facilities, study tours, summer schools and financing guidelines, as well as the newly developed decision support tool for identifying the suitable form of aquaculture in your region. All of which are designed to encourage the aquaculture sector within the region.

But our brochure can only give a small insight into the abundance of possibilities. You can discover much more by studying the numerous reports available on our website and especially by becoming an active member of the Aquaculture working group of the SUBMARINER Network. Together, we will continue to organise study tours, match-making events, expert round tables and workshops following our members' needs, as well as continuously developing new initiatives.

Expressing our gratitude to all InnoAquaTech partners and its Advisory Board for their tremendous work and never-ending enthusiasm, we believe that this is indeed the start of a new journey. We look forward to working with all parties interested in continuing to foster innovative aquaculture in the BSR and beyond.



Angela Schultz-Zehden

SUBMARINER Network
for Blue Growth EEIG



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Aquaculture in the EU and in the Baltic Sea region

Farming finfish, shellfish and aquatic plants is one of the world's fastest growing food sectors; it already provides the planet with about half of all the fish we eat.

Seafood consumption in the EU is expected to increase, especially in Central-Eastern Europe, where, on average, one EU citizen consumes 25 kilos of fish and seafood per year*. However, 60% of fish and seafood consumed in Europe is imported, 25% of which is coming from aquaculture.

As the seafood market demand is on the rise and sustainable fishing can-

not keep up with this demand, aquaculture is the single most promising food production sector with such a tremendous potential to grow. On a global scale, with the aquaculture sector growing at a rate of 6% annually, aquaculture is expected to surpass fisheries in the near future, thus reflecting the trend that farmed fish is becoming the rule.

There are already approximately 14,000 companies engaged in aquaculture in the EU, most of them SMEs, that employ in total about 85,000 people (about 6 employees per company on average). In 2016, the EU aquaculture

* https://ec.europa.eu/fisheries/6-consumption_en





sector produced and sold 1.4 million tons of seafood, worth almost €5 billion, doubling the profits in the sector between 2014 and 2016.

The largest seafood producers in the EU are Spain, UK and France, although Norway (an EEA country) is producing the same volume of seafood as the

whole of the EU industry put together and is the main supplier of farmed fish outside the EU.

Aquaculture, together with blue biotechnology, is one of four sectors highlighted in the Implementation Strategy for the Sustainable Blue Growth Agenda for the Baltic Sea Region (2017) and is also a strategic sector in the updated Bioeconomy Strategy (2018) for food, feed, and industrial products.



Peter Jessen from FREA
Aquaculture Solutions,
Denmark



In 2016, the total volume of Danish aquaculture production amounted to over 45,000 tons. About 90% of the production is exported, predominantly to Germany. Rainbow trout accounts for 60% of the total production, out of which one third is by sea cage farming. Blue mussels farming is present in the Danish fjords (the northern part of Jutland). The second segment of production, land-based fish farming, has a long tradition in Denmark. Today, more than 200 farms exist that use mostly ponds, but also raceways and some recirculation aquaculture systems (RAS). Besides trout, farmed fish species include European eel, pikeperch, turbot, and minor quantities of salmon.



Domestic German aquaculture production – about 25,000 tons per year between 2012 and 2017 – is far from being able to meet the customers demand (80% of fish and seafood consumed is imported). Freshwater farming is dominated by basins, flow channels and pond systems. About 40 aquaculture enterprises are located in the northern part of Germany, mainly producing trout and carp in ponds. Other production systems in operation include cold-water flow-through systems for trout and warm-water RAS for shrimp and African catfish. Most of the marine production of blue mussels is located at the German North Sea coast.



In Poland, total national aquaculture production reached 38,600 tons in 2015 (an 8% increase compared to 2013). Land-based freshwater farms relying on traditional ponds are still the predominant. The largest share has carp production, yielding 19,000 tons per year (>50% of the total aquaculture output). Rainbow trout production reached 15,000 tons per year. Recently, recirculating aquaculture systems have been established for the production of trout and salmon, but also for new species such as tilapia. The Polish fish-processing sector went through considerable transformation and, at present, it is one of the largest in Europe. Although the average annual fish consumption is below the EU average, there is a growing awareness among Polish consumers of fish and seafood products.



The Lithuanian aquaculture sector produces around 7000 tons of fish per year. The sector comprises 18 enterprises dedicated to fishery and aquaculture, two aquaculture closed system enterprises for eel rearing, a natural salmon breeding farm and over 50 farmers who carry out fish pond aquaculture on a commercial scale. Most of the production systems in operation are warm-water ponds for carp breeding. There is also cold-water aquaculture for trout and whitefish. Trout, salmon and sea trout are bred in closed systems. The first recirculating system in Lithuania was established for salmon and sea trout propagation.





Algae PhotoBioReactor of DTI
at University of Rostock, Denmark

What was the aim?

The aim of the InnoAquaTech project was to increase the innovation capacity of small and medium enterprises (SMEs) and their support organisations, as well as enable them to develop and implement cross-border value chains for sustainable food markets. Special emphasis was given to recirculating aquaculture systems (RAS), new species and innovative combinations of RAS with e.g. plant production (aquaponic systems) and/or renewable energy.

For this purpose, the InnoAquatech project implemented four aquaculture pilot showcases located in Germany, Denmark, Poland and Lithuania. From these, valuable data, practices and lessons learned on practical, technological and economic aspects were extracted and used for the development of a decision support tool for potential new aquaculture practitioners and investors; a truly useful service for SMEs.

To increase the durability of findings and tools, the project has established the transnational and cross-sectoral 'Aquaculture working group' under the SUB-MARINER Network to facilitate closer cooperation and knowledge exchange between different stakeholders in the region.

Who was involved?





What have we developed?

- A **user-friendly Decision Support-Tool (DST) for RAS investors and practitioners**, that indicates the technological and economic opportunities in land-locked aquaculture at regional level. The online tool was partially developed on the data and experiences extracted from the four pilots from Germany, Denmark, Poland and Lithuania.
- Results from **four pilots**:
 - Feasibility report on innovative aquaponic systems production; combining lessons learnt from two pilots on aquaponic systems from Germany and Denmark
 - Prototype and feasibility study on RAS shrimp production based on geothermal technology in Lithuania
 - An evaluation of the potential of crustacean production in RAS in Pomerania, Poland
- A **Whiteleg shrimp info-portal** developed from the Polish pilot with relevant information for future activities, which aim to start Whiteleg shrimp production especially in the Pomeranian region of Poland
- An **SME service offer package** for RAS entrepreneurs and practitioners, consisting of networking and matchmaking events, study visits, summer schools and trainings, and **financing guidelines**
- The **Aquaculture Working Group** under the SUBMARINER Network EEIG, that sustains the SME service offer package beyond the project lifetime.
- The **Aquaculture website**, hosted by the SUBMARINER Network, as the networking and communication platform of the BSR aquaculture community. The platform publishes news and events of the aquaculture working group and its members, promotes the outputs of the InnoAquaTech project as well as other relevant aquaculture initiatives in the region.



Integration of pilot facilities in Germany and Denmark: aquaculture and plant — or microalgae — production



African catfish,
DTI pilot at Guldborgsund Zoo, Denmark



Aquaponics and fish production in the FischGlassHaus

Since 2015, the FischGlassHaus at Rostock University, with a total area of 1000 m², is one of the most modern experimental aquaponics research facilities in Europe. About 30% of the area is available for fish production and 60% for plant production. During

the InnoAquaTech project, advanced experiments were carried out focusing on analyses and evaluation of the nutrient fluxes and possible reuse strategies depending on the fish cultivated – tilapia (*Oreochromis niloticus*) and African catfish (*Clarias gariepinus*).





Integrated RAS and microalgae cultivation

With the purpose of testing whether effluent waters from modern RAS systems can be used in an economical and sustainable microalgae production, Rostock University (UROC) and Danish Technological Institute (DTI) have worked together on the system in 3 phases:

1. Lab-scale analysis and testing of suitable microalgae cultures for cultivation in fish effluent water.
2. Pilot demonstration RAS facility with African catfish (*Cl. gariepinus*), combined with outdoor microalgae basin cultivation established at Guldborgsund Zoo (DK) with focus on dissemination.
3. Establishment of cultivation facilities for microalgae in a photo-bioreactor (PBR) (equipment and material transfer from DTI to UROC) for continual upscaled cultivation trials.

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Joint outcome

Nutrient analyses of RAS sediments were used to identify best re-use strategies, integrating the untreated effluent water with a photobioreactor with microalgae. Experiments conducted between DTI and UROC proved that microalgae can grow in effluent water from aquaculture, and they can be an efficient way to remediate nutrients. The RAS pilot and demonstration was very successful with 100% survival rate of the African catfish. Also, a new re-use of the RAS sediment was applied in the form of vermifiltration, demonstrating proof of concept and significant reduction of Biological Oxygen Demand (BOD). The aquaponics research, using plants to clean the process water of nutrients, showed that selective addition of

fertilizer is required for most crops in order to avoid nutrient deficiency.

Strong focus was on demonstration and dissemination in the Danish pilot RAS – the facility was open to the public at Guldborgsund Zoo and was seen by more than 26,000 visitors. In collaboration with Guldborgsund Zoo, the InnoAquaTech project reached out to local schools and there were 4 seances of teaching the next generation about RAS aquaculture and aquaponics.

The FishGlassHaus will continue to be a nucleus for further aquaculture innovation, including education and training in form of practical courses and workshops, as well as eLearning modules.



RAS Pilot
at University
of Gdansk

Crustacean production in RAS system – demonstration facility in Pomerania

In the course of the InnoAquaTech project period, the first ever demonstration facility for crustacean production in RAS in Poland has been established at the University of Gdańsk. Two whiteleg shrimp breeding experiments were carried out; shrimps (*Litopenaeus vannamei*) were grown at 25°C and with a salinity of 28 PSU. Their nutritional value, i.e. contents of protein, fat, energy, fatty acids and solu-

ble vitamins, protein digestibility, as well as chemical contaminants: mercury, lead, cadmium, organochlorine pesticides and polychlorinated biphenyls, were examined and compared with market shrimp species from different geographical regions.





The purpose of the pilot in Pomerania was to raise the awareness of potential consumers to the fact that cultured crustaceans are characterized by a similar nutritional value to those of imported crustaceans, and contain higher levels of polyunsaturated fatty acids. The faci-

lity will be further developed and used for demonstration within future international projects, for both experimental and educational purposes.

You can follow the developments of the facility here: <https://krewetka.ug.edu.pl/>

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Litopenaeus vannamei
shrimps grown in
University of Gdańsk pilot plant



Whiteleg shrimp
grown in the Klaipėda
University pilot facility

Experimental shrimp farming facility in Klaipėda

Thanks to co-financing of 100 000 EUR from Interreg South Baltic via the InnoAquaTech project and with expertise from Germany, a zero emission RAS facility has been established at the Klaipėda University.

The RAS is heated using geothermal energy, making it a sustainable and innovative option for aquaculture businesses. Klaipėda Science and Technology Park is in charge of overseeing its activities. The first experimental whiteleg shrimp production took place in 2019 from shrimp larvae

imported from Scotland. The yield was 200 kg, although the facility has a potential production of 400 kg.

The knowledge acquired during the testing of the new technologies will be used to support new business activity and to increase competitiveness for the Lithuanian aquaculture industry. Given the lower production costs



Klaipeda University pilot facility

of the crustaceans, they could also be produced for export to foreign markets. The goal is to build on this experience and to further use the facility to

gain more competences as well as to carry out a targeted marketing of the shrimp breeding business in Lithuania.

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whiteleg shrimp

International business study visits

Three “external to the South Baltic area” study visits have been organized during the InnoAquatech project, with the aim of gathering and sharing knowledge about innovative aquaculture business models and helping build capacity for the South Baltic region’s aquaculture industry. Participants of the study visits were primarily industrial stakeholders for applying the knowledge, representatives from R&D institutions for gathering expertise and business support organizations for network-building for successful application of the technologies and the increase of business potentials.

- In March 2018, a 3-day study visit took 16 participants to Iceland, with a focus on geothermal energy, fish aquaculture, aquaponics and micro-algae production
- In November 2018, a 3-day study visit took 20 participants to Belgium

to learn more about the innovative approaches of Flemish land-based aquaculture, aquaponics and unique farmed species, incl. sturgeon, fish and shrimp.

- Finally, in May 2019, a 2-day study visit took 19 participants to Jutland, Denmark giving SMEs in the South Baltic Region the possibility to exchange directly with the actors behind some of Denmark’s state-of-the-art aquaculture technology and feed industry.

The study trips were all highly acclaimed and they were regarded as a huge success in many ways. The study trip instrument has been rated very positively by end-users. From a participant evaluation survey, the study visits are considered the right approach to addressing the actual need for field knowledge transfer in innovation, and participants responded that they



HS Orca, Iceland 2018



would be willing to pay for such a service in the future.

The activities of the study visits also had a matchmaking and business development purpose. As a direct result of the Belgian study visit, two EU applications (Horizon2020 and ERA-Net) were made, developed by newly formed consortia made up of actors introduced during the visits and through personal contact and

insight into their respective businesses. Furthermore, the participation of the Danish Agriculture South in the Belgian visit has stimulated the interest of agricultural farmers local to Guldborgsund, Denmark. The branch organisation is assessing the potential of using RAS technology for alternative protein production, as well as exploring alternative local protein crops and insect bioconversion technology for new ingredients for fish feed.

Advisory services for business development

The project partners have gathered state of the art information and also developed new knowledge within integrative innovative aquaculture systems relevant for the Baltic Sea Region. This knowledge has been made available to new practitioners, investors, R&D and other people that are interested and curious about the technology and its potential in an

applied form. As a result, consulting services have been on offer on a demand-driven basis e.g. assessment of business potential, technical/scientific support, product development, legal advice, financing guidelines.

To support this effort, a number of tools and solutions were developed, which are described on the following pages.



CreveTec,
Belgium



FREA
Aquaculture Solutions,
Denmark

Decision Support Tool

The InnoAquaTech Decision Support Tool (DST) addresses technological, environmental and economical dimensions of aquaculture facilities. Users of the tool can compose a virtual aquaculture facility by specifying its technological, biological and economical properties. As a result, the

tool provides an overview of resource and money flows for the specified aquaculture setup.

The DST has been developed by University of Rostock and Danish Technological Institute and is available online.



FREA
Aquaculture Solutions,
Denmark

Investment guidelines for RAS aquaculture

The purpose of the brochure is to help potential investors in preliminary decision-making, presenting the resources that are needed. The brochure is also for investors who have no previous experience in aquaculture. The report explains the basic terms used in this sector, the basic technical and technological description of African catfish and whiteleg shrimp cultivation.

In the case of the African catfish, the whole analysis was based on data from real, functioning SMEs in the South Baltic, collected as part of the project and analysed for precautionary planning of future businesses. Regarding whiteleg shrimps, the data comes from the few already operating businesses in the South Baltic area, pilot installations operating under the InnoAquaTech project, data from

literature and from suppliers of technology and stocking material.

Furthermore, the report contains a multi-dimensional model for a few selected production scales. The model describes the expected capital (investment) needs, the operational cost account, and finally the analysis of return on investment on a scale of 10 years at full production capacity. This is accompanied by recommendations regarding financial assembly – considering traditional and innovative sources of financing.

The report has been developed by National Marine Fisheries Research Institute for InnoAquaTech and is available online and can be downloaded from the SUBMARINER website.

Summer Schools



Two 3-day events have been organized within the project with an aim to provide SMEs an access to knowledge and competences within the innovative aquaculture sector: **Innovative aquaculture – whiteleg shrimp – *Litopenaeus vannamei* summer school** in Gdynia in September 2018 and the **Aquaponics summer school** in Rostock in March 2019.

Summer schools were directed to aquaculture entrepreneurs, potential investors and specialists interested in RAS technology, fish and microalgae production, crustacean farming and aquaponics. The participants represented various sectors: aquaculture, animal nutrition, consulting, breeding equipment and production setup, fish transport, fishing, as well as pharmacy, veterinary medicine, animal

production, aqua-feeds, product economics, ornamental fish retail market, business modelling, seafood import and retail market, aquaponics experts, farmers, and the IT industry.

Conclusions from both events show that market conditions for future production seem to be very promising although public awareness about these products is still very poor. It is worth engaging the restaurant sector into the promotion of new products such as RAS shrimps or aquaponic plant products.

Based on these experiences, we believe the summer schools to be an efficient and useful tool to raise awareness and share knowledge and both universities aim to organize further events.



Summer school
in Rostock, 2019



Gdynia summer school,
September 2018

Gdynia summer school

A summer school was organised by the University of Gdańsk in September 2018. It focused on practical requirements related to the import of live animals for breeding, feeding program for shrimps and issues related to diseases and pathological changes in marine invertebrates, operational costs and practicalities, fish feed and feeding alternatives. Over 30 participants shared their experiences with different aquatic species bred in innovative

recirculation systems in the Pomerania region. The following topics proved to be of interest for further discussions: breeding eco-shrimps in RAS technologies, production on an industrial scale, breeding technologies including automation, nutrition of aquatic organisms, diseases and pathogens, as well as innovative forms of disease prevention in aquaculture, distribution of seafood on the Polish market, consulting and business setup.

Rostock summer school

A second summer school was organised by the University of Rostock in March 2019. It focused on animals and plants in aquaponics, further use of particulate nutrient excretions from aquaculture animals by vermifiltration (worm filtration) and quality control of cultivated African catfish. During discussion rounds 40 participants had the opportunity to ask questions and

exchange experiences. It was noted, that although a large number of relevant questions for science and practice have already been addressed, new questions and ideas arise continuously. This led to the conclusion that there is further need for both basic as well as applied research by means of new national and international projects.



The Aquaculture working group of the SUBMARINER Network

As the 'one-stop-shop' for sustainable aquaculture promotion within the Baltic Sea region, members of the InnoAquaTech project have joined forces to form the Aquaculture working group of the SUBMARINER Network for Blue

Growth EEIG. Together they will continue to address aquaculture practitioners, technology providers and investors as well as other R&D partners through the following activities:



InnoAquaTech Project Partners, Advisory Board, and SUBMARINER Network representatives, meeting in Vejle, May 2019

InnoAquaTech project partners have agreed to continue offering the SME service package beyond the end of the project, coordinated under the umbrella of the SUBMARINER Network.



- one-stop-shop for relevant information on sustainable aquaculture; offered services (incl. accessible demonstration plants) by its members
- study visits to aquaculture sites inside and outside the BSR on a demand-driven basis
- matchmaking events for aquaculture practitioners to find the right Baltic Sea Region partners to complete product development value chains
- connection to R&D, regional development actors as well as industry innovators
- cross-sectoral interlinkage to actors from other blue bioeconomy thematic fields, e.g. blue biotechnology, mussel farming, algae, multi-uses of sea, beach cast, marine litter etc.
- summer schools, dedicated workshops and training courses on tailored topics on a demand-driven basis
- access to the InnoAquaTech Decision Support Tool, which addresses technological, environmental and economical dimensions of aquaculture facilities.
- identification of funding and investment opportunities and dedicated partner collaboration in proposal development
- consulting services on offer through the SUBMARINER members on a demand-driven basis; e.g. assessment of business potential, technical/scientific support, product development, legal advice and financing.



The SUBMARINER Network for Blue Growth EEIG

The SUBMARINER Network for Blue Growth EEIG is the leading transnational networking hub in the Baltic Sea Region that promotes sustainable and innovative uses for marine resources. It is a flagship initiative of the EU Strategy for the Baltic Sea Region.

Since 2013 the Network provides for communication and match-making as well as action and strategy development across the various marine sectors, including aquaculture and blue biotechnology, by connecting R&D with regional development and industry innovation. With twelve transnational blue growth projects on board, in mid-2019 the Network is also operating through various thematic Working Groups, each having its own members and bottom-up agendas.

The SUBMARINER Network portal is the one-stop-shop for products and services featured in this brochure, as well as for information on actors, data and initiatives relevant to all thematic fields within the blue bio-economy in the Baltic Sea Region and beyond.

Are you interested?

Visit the SUBMARINER website:
www.submariner-website.eu

Subscribe to our newsletter and stay updated for networking and match-making events, upcoming study visits and summer schools.





Aquaculture Virtual Career Development Platform for the South Baltic region – AquaVIP

AquaVIP, a follow-up to the InnoAquaTech project, will focus on boosting education with the aim of a better prepared labour force and business capacity in innovative aquaculture. AquaVIP will build on our experiences with capacity building in aquaculture competences and modern aquaculture technologies (e.g. aquaponics, microalgae cultivation and RAS) from projects such as InnoAquaTech and other national and European projects. The ultimate goal of the AquaVIP project is to create a virtual career and mobility center for the innovative aquaculture sector. The AquaVIP project will be featured on the SUBMARINER Aquaculture website.

Project consortium: KSTP (Lead Partner),
Rostock University, University of Gdańsk, Klaipėda University

Planned project duration: 1 Jan 2020 – 31 Dec 2022

AquaVIP will be funded by the Interreg South Baltic programme



European
Regional
Development
Fund

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